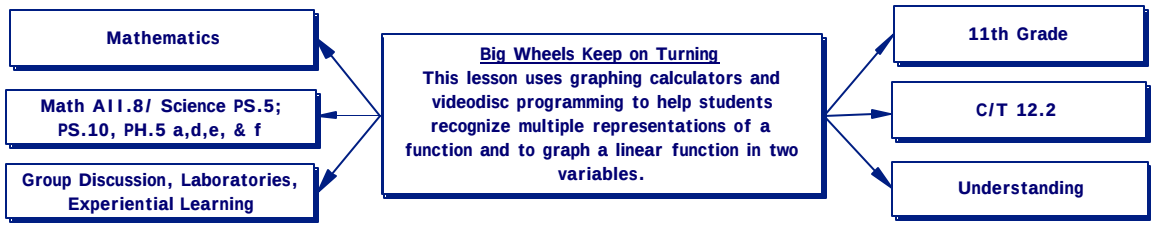

Big Wheels Keep on Turning

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Curriculum Area	Mathematics
Subject Area	Algebra II
Grade Level	11th grade
Learning Objectives	• The student will be able to graph a linear function in two variables. • The student will be able to recognize multiple representations of function (quadratic, absolute value and exponential functions). • The student will be able to investigate and understand changes in matter and the relationship of these changes in the Law of Gravity. • The student will be able to understand the scientific principles of gravitational force, speed/velocity and acceleration.
Correlation to the SOL	Math AII.8 Science PS.5, PS.10, PH.5 a, d, e & f C/T 12.2
Video/Technology Hardware/Software Needed	**For class:** Computer Calculator Based Laboratory (CBL) or Calculator Based Ranger (CBR) equipment and software TI-82 or TI-83 Graphing Calculator with Motion Program and Unit to Unit Link Cable for Motion Program Vernier Ultrasonic Motion Detector Overhead Projector Overhead TI viewscreen for the TI-83 Television Monitor and VCR **For each group of 3 students:** Computer connected to printer Calculator Based Laboratory (CBL) or Calculator Based Ranger (CBR) equipment and software TI-82 or TI-83 Graphing Calculator with Motion Program and Unit to Unit Link Cable for Motion Program Vernier Ultrasonic Motion Detector **Video:** *Math Vantage #7: What's Your Angle?*

Materials Required	**For each student:** A copy of the Evaluation Exercise **For each group of 3 students:** Friction-powered vehicle with big wheels (students can build match box cars or buy trucks from your local toy store) Inclined ramp, about 5 feet long and 1 foot wide (ask the technology department for assistance). Index card attached to front of car with tape A copy of the Motion Data Sheet
Procedures/Activities	1. Form students into cooperative learning groups of no more than 3 per group. 2. Tell students: to practice pushing the cars up the ramps to see how force determines the speed and distance. As the students practice this in class, have each student take out their notebook and make a prediction on speed and force. 3. Have each cooperative group create two lists of data. List 1 will include their predicted speed, and List 2 will include their time. Have each group load this data in their graphing calculator in L_4 and L_5. If students do not have graphing calculators, you can have them list the data in their notebook, and find the slope with pencil and paper. 4. Cue the video *Math Vantage #7*: *What's Your Angle?* Tell students the problems that confront many people in a wheelchair will be highlighted in this video. With the volume off, start the video about two minutes from the beginning where Christina sees the ramp in front of the building and stop the video when Christina approaches the ramp. Question the ideas of gravity and force at this point in the video. Resume with sound, where Christina discusses how going up a ramp is very difficult in the wheelchair. Explore what can be done to make this process simpler for all people in wheelchairs or handicapped in any other way. 5. Post the following mass on the board: M = 20; M = 35; M = 55. Have students perform their calculations before using the CBL. 6. Students can now use the CBL to gather data in their cooperative groups. When the car is given a push up the ramp, it should slowly come to rest as it reaches it highest point, then return to its starting point. The entire process should take several seconds (usually less than 10 sec) 7. Adjust ramp so that the motion occurs as described above. Practice pushing the car up the incline. 8. Have students refer to Section I on the Motion Data worksheet and sketch their graph predictions. 9. Secure the motion doctor at the top of the ramp. At no time should the car come closer than 2 meters from the detector. 10. Start the Motion Program on the TI-82 and follow the directions on the screen. For the first option, choose #2 - COLLECT DATA. For the second option, choose #1 - REAL TIME. 11. By choosing "real-time" the graph will be displayed on the screen as the car is moving. If students are not satisfied with the results, they can start again by pressing [CLEAR] [ENTER]. For the teacher using the CBR, the program motion can be downloaded to the graphing calculator under the name "Ranger." 12. Next, have the students refer to the Motion Data worksheet and answer II - VIII. 13. Run the MOTION Program again. This time choose for the second option #2 - NON-REAL TIME. With this option, no graph will be displayed as the car is moving. The following menu will be displayed: **OPTIONS**

	1. DISTANCE-TIME 2. VELOCITY-TIME 3. ACCELERATION-TIME 4. QUIT 14. Students will need to look at each of these graphs. If they are dissatisfied with their results, press [CLEAR] [ENTER] to start again. 15. Once the group is satisfied with their results, they should complete the rest of the Motion Data worksheet.
Content Assessment	Use Evaluation Exercise.
Technology Integration Assessment	Use Evaluation Exercise.
Extensions	**English:** Have students develop a written guide to help people build ramps that are appropriate and useful for the handicapped, based on their findings. **Science:** Have students experiment with different materials which might provide different rates of friction on ramps. Ask them to determine which types of material offer optimum assistance to the handicapped.

Evaluation Exercise

Ask the class to describe how the data is changing in graphing calculator using [STAT] L1 and L2, on the teacher's overhead graphing calculator. Tell the students in each group to link the data to each person in the group after completing the experiment. Tell each group of students to find the slope, identify the domain and range. Find the y-intercept and graph the equation of the line. Tell the class to plot on the [STAT PLOT] MODE and graph the results on graph paper.

Next, have the students find the best fit line using lin/reg, quad/reg or exp/reg. Then paste the graph onto the [STAT PLOT] mode of the graphing calculator. If students do not have a graphing calculator, have each student copy data from overhead as ordered pairs. Then have students find the slope, y-intercept, and write the equation in standard form. Tell the class to graph their findings and explain if the graph best describes the experiment.

Tell each group to link data from one group to the next in L_5 and L_6. Tell students find the best fit line using lin/reg, quad/reg or exp/reg. Show the graph in Plot #2.

Motion Data Sheet

For all numerical answers, round to the nearest tenth.

I. Distance

A. Sketch the *distance-time* graph that you think will result from the car's motion.
B. Sketch the *velocity-time* graph that you think will result from the car's motion.

Sketch your REAL-TIME distance graph below and use it to answer the following questions.

II. How far up the ramp did the car travel?

III. How long did it take the car to reach this height?

IV. What happened when the car got to the top?

V. When was the car moving the fastest?

VI. What was the total time for the experiment to run?

VII. For this data, state the domain and range.
Domain:_____Range:_____

VIII. Describe the shape of the graph.

Sketch your NON-REAL-TIME graph below and use it to answer the following questions.

IX. What is the total distance traveled by the car?

X. At what time is the car closest to the motion detector?

XI. Was the velocity constant?
if so, what was the velocity?_____
if not, was the speed greater going up the ramp, or down the ramp?_____

XII. How does this relate to Christina's problem as she tried to get around in her wheelchair? Explain

XIII. What is the car's initial velocity?

XIV. What is the car's velocity when it is closest to the motion detector?

XV. Describe in words the shape of the velocity-time graph?

XVI. What is the domain and the range of the velocity-time graph?
Domain_____Range_____

XVII. Explain in words how your original predictions compare with the real data.